UNIVERSAL DESIGN APPLICATION THROUGH SOUTH KOREA REDEVELOPMENT
(A Study Review)

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Abstract
The evolution toward Universal Design was began in the 1950s with a new attention to design for people with disabilities. At the same era South Korea began their development after several wars. Recently some of researchs and projects in South Korea which conducted on Universal Design concept are increasing in quantity and widening in multidiciplinary areas to make a better living for people in South Korea.
This study examined those researches and projects to determine the progress of Universal Design principles application in South Korea in several periods and evaluated the result by the project's purpose. This study is a review from several literatures related to universal design application in South Korea.
The Review revealed that South Korea has published regulations, guidelines and law based on universal design principles. South Korea has established universal design principles as fundamental basis in designing and developing their public space, public facilities building and elderly residential houses. Application of universal design influenced the knowledge of diversity for people especialy in disability and elderly. Universal design encourage people with diversity in ability, ages, gender to live together without barrier to access and use every facilities in their regions.

Keywords **:** *Universal Design, Development, South Korea, Review, Diversity*

INTRODUCTION

Universal design (also called inclusive design or accessible design) refers to facility designs that accommodate the widest range of potential users, including people with mobility and visual disabilities and other special needs. The evolution toward Universal Design was began in the 1950s with a new attention to design for people with disabilities. Universal design (also called inclusive design or accessible design) refers to facility designs that accommodate the widest range of potential users, including people with mobility and visual disabilities and other special needs. Universal design should be comprehensive from origin to destination for the greatest possible range of potential users. Universal design should consider all possible obstacles that may exist in buildings, transportation terminals, sidewalks, paths, roads and vehicles.

At the same era South Korea began their development after several wars South Korea is one of the countries that applied universal design principles in public spaces and public buildings. South Korea applied it to ease the access for the elderly and disabled. The condition was happened because the number of this last category in South Korea is steadily increasing due to congenital disabilities, aging and the increase of physical impairments from accidents (see table 1). In other hands, the people with disability also have the same rights to live in South Korea without any discriminations. This conditions need to be responded by the government with their authority as described on national constitutions.

Table 1. People with Disability Employment in South Korea

degree of disability	2013	2012	growth rate
1	423	492	-14.0
2	2,024	1,964	3.1
3	3,301	3,026	9.1
4	1,137	1,093	4.0
5	1,390	1,239	12.2
6	1,899	1,643	15.6
7	47	28	67.9
overall	10,221	9,485	7.8

.(Source:KEAD, 2013 on https://www.kead.or.kr)

The projection South Korea population based by the ages shown that number of elderly will increase constantly each year (see table 2). That condition needs to be responded by government and scientist to facilitate and anticipate the prediction. Therefore several project and research are running in this study area.

Table 2. Population of Elderly in South Korea

unit thousand persons % per 100 female population

Period	65 or more	Males		Females		Sex ratio
			Share		Share	
1990	2195	882	3.8	1373	6.4	59.8
2000	3395	1300	9.5	2095	9	62
2010	5452	2227	9	3225	13.1	69.1
2014	6366	2658	10.5	3728	14.8	71.3
2020	8084	3451	13.5	4633	18	74.5
2030	12691	5682	21.9	7010	26.7	81.1
2040	16501	7460	29.5	9041	35	82.5
2050	17991	8151	34.3	9841	40.4	82.8
2060	17662	8197	37.7	9425	42.5	87

(Source: Statistic Korea Population Projection, 2011 on http://kostat.go.kr)

In aims to anticipate and facilitate the elderly and disability right, South Korea starts to study and apply universal design principles on every buildings and public facilities from early 80's as the rise of Korea development begins. South Korea together with China and Japan were developed universal design for the three nations, with the aims having standard adopted the world wide.

Following those trends and focused on South Korea, this study examined those researches and projects progress of Universal Design principles application in South Korea in several periods and

evaluated the result by the project's purpose. In other means, this study review from several literatures related to universal design application in South Korea.

UNIVERSAL DESIGN STUDY IN SOUTH KOREA

Universal design is worldwide design movement as support for independence and participation has evolved in response to demographic expand and social condition of more people living with a wide range of disabilities and various health conditions than before and the longest lifespans in records. Universal Design is the design of products, environments, and communication to be usable by all people, to the maximal extent possible, without adaptation or specialized design. The concept is also called inclusive design, design-for-all, lifespan design or human-centered design.

Universal design is a philosophy of design which removed distinctions among varying abilities by adhering to four major principles which identified by Ron Mace:

1. **supportive:** it makes environments work for the individual, stressing ease of use and maintenance.
2. **adaptable:** it serves a wide range of users whose needs change over time.
3. **accessible:** the everyday comforts and conveniences that "normal" individuals enjoy are provided to all users of the environment.
4. **safety:** it not only provides environments and tools for the presently disabled, but also anticipates and prevents disabilities such as repetitive strain injuries.

The further developments of these principles have provided a standard to the products and environments which can be measured (Null, 2014). As the movement has grown, universal design principles have continually been evaluated and refined. The center for universal design at North Carolina developed an expanded list of seven principles of universal design which were represented by ten UD advocates as : Bettye Rose Connell, Mike Jones, Ron Mace, Jim Mueller, Abir Mullick, Elaine Ostroff, Jon Sanford, Ed Steinfeld, Molly Story, and Greg Vanderheiden. The list of seven principles of universal design are :

1. **Equitable Use :**
   The design is useful and marketable to people with diverse abilities.
2. **Flexibility in Use :**
   The design accommodates a wide range of individual preferences and abilities.
3. **Simple and Intuitive Use :**
   Use of the design is easy to understand, regardless of the user's experience, knowledge,

language skills, or current concentration level.

4. **Perceptible Information :**
   The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
5. **Tolerance for Error :**
   The design minimizes hazards and the adverse consequences of accidental or unintended actions.
6. **Low Physical Effort :**
   The design can be used efficiently and comfortably and with a minimum of fatigue.
7. **Size and Space for Approach and Use :**
   Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

The application of Universal design principles in South Korea has been performed in several case and multidisciplinary views. This study has resumed in period of 90es until recent South Korea development through universal design into 3 section of better living aspects, which are :

1. Residential facility (Home)
2. Workplace/ Education (Work)
3. Leasure/recreation place (Play)

RESIDENTIAL FACILITIES

South Korea has developed many guideline and projects conducting silver town for elderly and kitchen for wheelchair access. The integrations of those study can be explained in this section. The kitchen studies were devided by two approach : 1) pre design study, 2)post occupancy evaluation which resulted more universal design kitchen without specialized for wheelchair users. The universal design concepts were developed into 4+3 principles whice derivated from 4 principles universal design plus 3 as described on figure 1.

1) Adaptable design
- The design should accommodate not only wheelchair users, but also their family members.
- The height controls of kitchen appliances should be easy.

2) Safety-oriented design
- The design should provide fail-safe features and isolate or shield hazardous elements.

3) Supportive design
- The design should be used efficiently and comfortably with minimum efforts.
- It should be designed for wheelchair users to store things at ease.

4) Accessible design
- The kitchen model should be created for people in wheelchairs to access it easily.
- Kitchen cabinets and counters should be placed within the reach of wheelchair users.

5) Aesthetics
- The appearance of kitchen model should not be different from the kitchens which general people use.
- The design should be harmonized with the interior where the kitchen model is located.

6) Cultural / regional considerations
- The design should reflect the specific dietary life of Korean people.
- It should maximize the small space of most kitchens in Korea.
- The design should accommodate the size of Korean people.

7) Cost
- The kitchen model should be produced at an affordable price.

Figure 1. universal kitchen design concepts
source : Ko, Young-Jun (2011)

This study found remodelling kitchen set which fit to Korea dietary life and affordable to be installed in apartements. This study suggested applicable alternatives for five unit types without increasing the current kitchen size. From this, the possibility for designing a more universal kitchen within the current kitchen area size has been demonstrated. Thus, it could be concluded that the usability and accessibility of the spatial layout of a kitchen would be more easily affected by the spatial distribution of appliances and the relationship between them than the size and shape of the kitchen. Therefore, for the application of universal design to kitchen design, considerations not only of the size and shape of the kitchen and its appliances, but also of clear floor space, work triangle, countertop, reach range, and knee clearance formed by the location of each appliance are required (see figure 2).

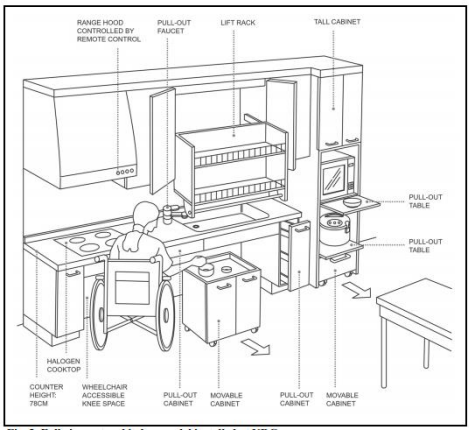

Figure 2. Kitchen sets integrated with korea dietary life
source : Ko, Young-Jun (2011)

The kitchen set design in bigger case can be applied as part of elderly house design or silvertown with some modification related the character, capacity and minimum facility that required by the house (see figure 3). The approach to elderly who have disability and low physical ability was applied in every rooms and spaces in this elderly house.

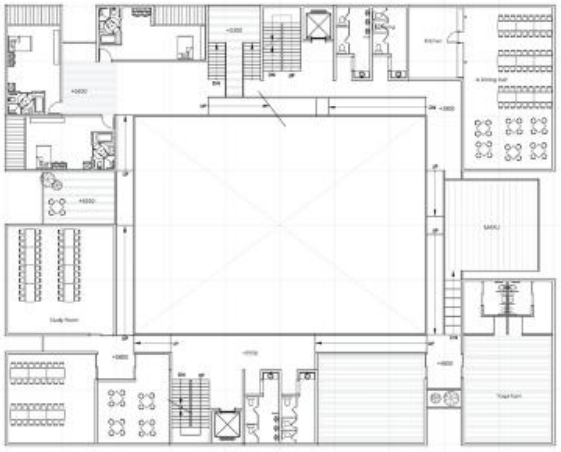

Figure 3. Integrated elderly unit design
source : sora, lee (2012)

The elderly houses is not just single support building. The concepts of integrity in living were promoted the house into city part which need to be connected with openspace (play) and community center (work). Diagram of connectifity between live-work-play which represented by housing-openspace-community center can be seen on figure 4. The connections between each place must be provided in every city especialy in metropolitan area to improve the living quality of every people.

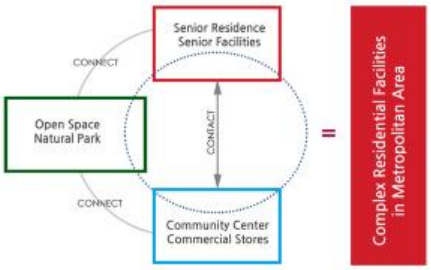

Figure 4. Integrated elderly house concept
source : sora, lee (2012)

WORKPLACE

South Korea is one of the countries which has employment problem especially in elderly re-employment since the employee demands are bigger than adult employee supply. The deficit must be solved by re-employment and disable people employment. Work requirement beyond individuals'

capabilities is often a factor in their injuries and poor job performances. This mismatch is more likely happen among older workers. Principles of "universal design" seek a safe, effective product and environment that people with widely ranging differences in age, size and other characteristics can use. Creating an age-friendly workplace is a collaborative work of ergonomics, human factors, and universal design. They together manage the challenges of balance, vision, hearing, strength and endurance faced by aging workers (Silverstein, 2006)

The specific parameter shown from Universal design in workplace is detailed on table 3 below. The parameter devided the features into physical and cognitive features.

Table 3. Universal Design in working place
source : Jeong, Byeong Yung (2014)

design elemen		features	
1. equitable in use	a. Provide the same means of use for all users	p	measurement of human body
		c	Display, warning device, operating device
	b. Provisions for privacy, security, and safetyshould be equally available to all users.	p	Protective Equipment
		c	Consideration of work stress
2. Flexibility in use	a. Provide choice in methods of use.	P	Hand tool, working order, work arrangement, equipment arrangement
		C	Working order, work arrangement, equipment arrangement
	b. Accommodate right- or left-handed access and use	P	Hand tool, work direction, equipment arrangement
	c. Facilitate the user's accuracy and precision	p	Location of display
		c	Direction of operation and measurements for display
	d. Provide adaptability to the user's pace.	P	Process speed, consideration of repetitive operation
		P	Visibility and preciseness of display and operating device
3. Simple and intuitive use	a. Eliminate unnecessary complexity.	p	Working order, verification inspection
		c	Simple display and operating device
	b. Be consistent with user expectations and intuition.	c	Basic model of display and operating device
	c. Accommodate a wide range of literacy and language skills	c	Display, monitoring work, work manual
	d. Arrange information consistent with its importance.	c	Display, monitoring work, component arrangement, operating device arrangement
	e. Provide effective prompting and feedback during and after task completion.	c	Warning device, alarm
4. Perceptible information	a. Use different modes (pictorial, verbal, tactile) foredundant presentation of essential information.	c	Display, inspection equipment, safety sign, communication methods

	b. Provide adequate contrast between essential information and its surroundings	c	Color, location, size of display
	c. Provide affordance	c	Shape, icon, operation button, design
	d. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.	c	Warning, sounds alarms, display
5. Tolerance for error	a. Arrange elements to minimize hazards and errors	c	Operating device, operation Information
		s	Prevention of malfunction, tamper proof
	b. Provide warnings of hazards and errors	s	Offer feedback
	c. Provide fail safe features.	s	Fail safe
	d. Discourage unconscious action in tasks that require vigilance.	s	Fool proof
6. Low physical effort	a. Allow user to maintain a neutral body position	p	Work at knuckle height, normal work area
	b. Use reasonable operating forces	p	Force limit for pushing and pulling, recommended weight of carry and lifting
		c	Indicator of heavy weight
		p	Hand tool, simple assemble of parts
	c. Minimize repetitive actions.	p	Protective gear and equipment
	d. Minimize sustained physical effort.	c	Work and posture training
7. Size and space for approach and use	a. Provide a clear line of sight to important elements for any seated or standing user.	c	Component arrangement, height of worktable
	b. Make reach to all components comfortable forany seated or standing user.	p	Component and tool arrangement, width of worktable, width of cart
	c. Accommodate variations in hand and grip size.	p	Hand tool, operating device
	d. Provide adequate space for the use of assistive devices or personal assistance.	p	Work space, reach distance, clearance

p =physical c=coginitve s=safety

This study suggests designs for workers (19-69 of age) including senior citizens. The measurements required for the designs are from the 2010 6th Size Korea (KATS, 2010 on kostat.go.kr), and are sorted by age and gender. The workplaces are divided into places that only have male workers, places that only have female workers, and places that have both male and female workers. The design measurements vary for each of these places. The research is only concerned with providing a maximum permissible area of horizontal handling and recommended range of handling heavy weight.

EDUCATION BUILDING

Universal design application on education building is related to the school facilities, including class and library. Several regulations related to the education building codes were published by the authority of South Korea. The universal design concepts were adapted on those codes, especialy in accessibility and perceptible information principles (see table 4).

Along with physical development related to universal design, the cognitive and knowledge about universal design also being studied in South Korea. The main purpose of universal design in learning is to elaborate the physical building and mental building inside every people to support each other. Korea young generation must know and learn about diversity in ability and cognition that need to be embraced and collaborated.

At several school in South Korea, people with disabilities were being facilitated to study together with other students without any special class for them. However, the universal design tools were installed in purpose to encourage their independence in living. There was study about awareness of diversity in students in elementary school which show a basic knowledge about accepting and understanding universal design in needs, some several question for identifying universal design knowledge can bee seen on figure 5.

Table 4. Universal Design on education buildings
source : Kim boil (2011)

Object	reference
Library Rules	Ch. 8 solution addition of library guidebook
Library Operation	Ch. 3 Library facilities and materials
Disability, elderly, Pregnant mother comfortness regulation	Ch. 4 accesibility
Disability, elderly, Pregnant mother comfortness operation	Ch. 3 facilities installment and management
Disability welfare regulation	Ch 22 accesibility in information
Disability anti discrimination rules	Ch 20 no discrimination in information acces
Copyright regulation	Ch.33 visual disability welfare

Table 5. question to the children

Source : Ko, Ae Gyeong(2012)

	About your friend who unable to do all by his/herself (autist)
	About your friend who don't notice what teacher says (deaf)
	About your friend who cant go up/ down stair alone (blind)
	About your friend who cant use the same desk (limb)
	About your friend who cant tell the story their favorite book (mute)
	About your friend who broken leg (weak)
	About your friend who cant move around freely (retard)

Table 6. Universal Design Principles Consideration on children at school

Source : Ko, Ae Gyeong(2012)

	Category	Sub category	Children answer
Universal Design Consideration	Universal Design Answer	Partial consideration	Comfy, amaze, danger, nice writing (21)
		Comprehensive consideration	Elderly, kids hurt but still able to access (1)
	No Universal Design Answer	Car Accident , death cause accident (7)	
	etc	Not understand and no answer (0)	

In conclusion, this study was found to be an effective method for changing young children′s understanding of the universal design concept and their understanding of young children with disabilities positively. As they understood the universal design concept and realized that individual′s abilities are different regardless of whether they have a disability or not, this concept may be applicable as an effective method to reduce fixed ideas or prejudices against disabilities (see table 6).

LEASURE/RECREATION PLACE

South Korea as one of the world top tourist destination is seriously prepare the infrastructure and facilities to be easily access and use by high range ability of tourist. Established tourist facilities for the disabled expands opportunities of tourism participation. The study proposed the deck model for improving disabled tourist activities in Hwajinpo tourists beach by applying universal design in terms of tour for all. The summary of result of this study was followed. The monitoring Hwajinpo beach was conducted and it found the present conditions and problems. Some improvements and deck model were suggested by applying the universal design according to the results. First, the efficiency of sandy beach deck needed to be considered. Second, equipping special wheel chairs were suggested. Third, installation of tracks for closing to the sea were suggested. Through those suggestions, the final deck mode was suggested for improving disabled tourists in Hwajinpo tourist beach. The application of universal design for facilitating travelling with disability was very important issues, so this study was very meaningful. It is expected that various ways will be suggested by applying universal design for encouraging travelling with disability focused on various tourism destination (see figure 5).

Figure 5. Universal Design adjustment in the beach
Source : Lee, Yongjin (2011)

Another study of recreation place is Geonjisan forest trail, Jeonju which won the competition of greening society on 2008. This project is good example in green design and universal design through mountainous area. The project was focused on pathway-rest area and exercise-rehabilitation area.

Figure 6. Application of Universal Design at Geonjisan
source : Park Sonah (2012)
a. pathway, b.personal restarea, c.collective rest area, d.rised rest area, e.accesible raiser, f.woodpath ground

The forest trail which had concept of woodpath and application of "bridge" above the topographic ground support the green-universal design proved that the ideal concept can meet the user satisfaction, especially for people aged over 60 years old who had been the participant in the post occupancy evaluation program (see figure 6).

THE IMPACT OF UNIVERSAL DESIGN IN SOUTH KOREA

The establishment of Universal Design in South Korea specialy in three sector mentioned above shown that the application is well installed and still developing into perfections.

In elderly housing (silver town) the relation between traditional habit of the occupant shown that universal design research can be started from specialized design to enrich the knowledge itself. The lift rack, lowered counter (sink), movable cabinet (under the cooktop), pullout cabinet, halogen cooktop, pullout tables which designed to facilite the disable people, can be used also by non disable user.

Along with the objective evaluations both in universal design and cultural aspects, subjective questions asking the usefulness on key elements such as counter height, knee spaces, movable cabinets, pull out tables, and lift rack etc., were given. As a result, the kitchen model was verified to

be useful in many ways, and some problems were also pointed out that need more adjustment to meet the universal design principles (see table 7).

Table 7. Universal reach range

Kang, Kyung-Yeon (2016)

Design element	Requirements
Universal reach range (vertical)	380-1,400mm
Universal reach range (horizontal)	<610mm
Height of countertop	760-860mm
Depth of countertop	410-610mm
Clearance between work surface and wall cabinet	>=380mm
Obstruction by projected base cabinet	<255mm

The kitchen study can be widen into house criteria with dynamic range of universal reach and applied in every elderly housing in South Korea. The application itself already reach every province in Korea, eventhough not all elderly house applied this design (see figure 7).

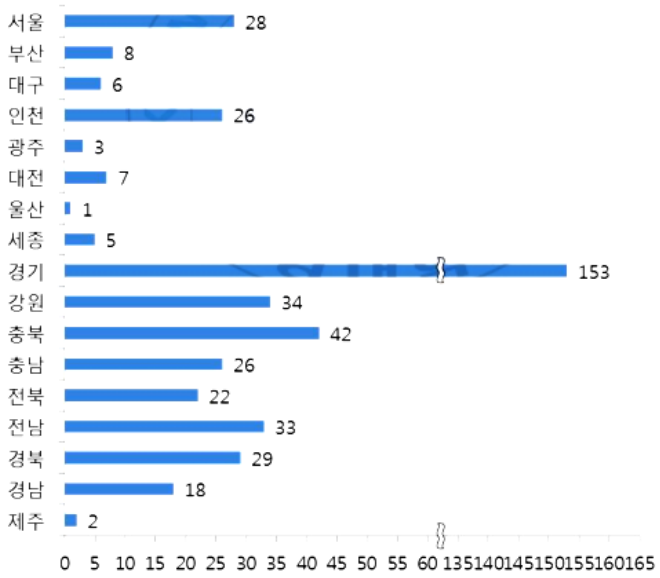

Figure 7 Universal Design applied Elderly Housing in South Korea

The redevelopment of kitchen in elderly housing shown that only 3.7% elderly feel uncovinient with the kitchen and 54,9% didn't feel uncomfort in the house. The next big issues which need to be develop are stairs (15,3%), toilets (12.55%) and entrances (9,1%) at their houses (see figure 8). This situation means house in South Korea is relatively safe to be lived and accessible cause the application of universal design principles.

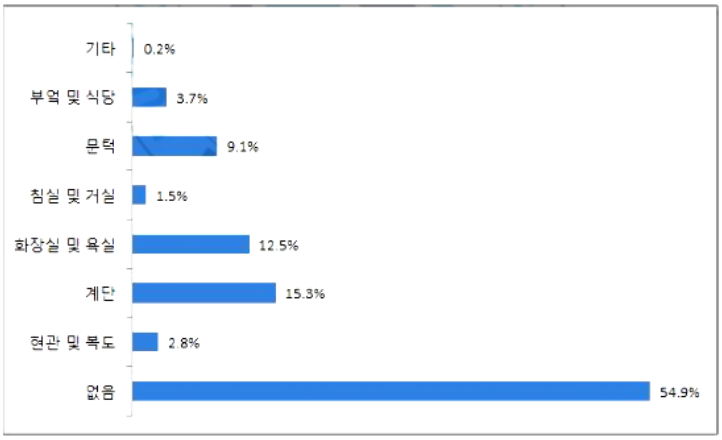

Figure 8. Elderly uncovinient places in house
Source : Jung-an, Jang (2016)

The second place for people is their workplace/school which spend almost 60% of their time in a day to live in. The growth of employee with disability and elderly made the workplace need to be more friendly to those people.

The Law for Building Accessible to and Usable by the Older and Physically Disabled Persons has made terms like "barrier-free design/ accessibility" and "universal design" more common related to physical, cognitive and safety demands. Implementing Universal Design in their product design is a recent trend there. Manufacturers and advertising agencies have built a new marketing strategy that even helped businesses recover from their long recession.

There needs to be a resting lounge for older workers and disable. Stairs and wheelchair ramps should be adjusted to proper height and angle to prevent accidents. Slippery floors should be fixed and handrails should be installed for the stairs. Proper lighting must be provided for the workplace and the hallway along with an indicator for whenever the floor is of different heights.

The recommend handling area for heavy weight items is from "knee-height" to "acromion height." The lower limit is set at 95 percentile of the highest "knee-height" so that worker with big builds would not have to bend as much. The higher end is set at 5 percentile of the lowest "acromion height" so that shorter workers would not have difficulty. The upper limit of the recommended material handling area from Table is set at 129cm for men usage, 118.3cm for women, and 120.2cm for general usage. The recommended lower limit from Table 4 is set at 48.8cm for men, 44.5 for women, and 47.8cm for general usage.

In the education section, the understanding amongst student about disability, diversity and universal design shown impact on advance education and lifelong learning participants. The elderly cohort in table 8 shown the high number in education participations. This situation convinced that the education facilities (ex:school, class, library, training,etc) had support every people to study again without boundary and discriminations. The social awareness found at the beginning of school also

create more tolerance and understanding amongst various people which support the universal education atmosphere.

Table 8 Life long learning in south korea by age cohort

Age	Public Training Centers	Skills Development Corporates	Private Institutes	Company Training	University, College, etc.
15-29	14.5	16.1	42.4	16.1	10.8
30-39	20.0	16.1	18.1	29.0	16.8
40-49	20.1	15.5	14.5	29.2	20.6
50-59	25.5	15.9	10.0	34.1	14.4
60-	33.5	12.6	5.4	25.1	23.4
total	19.4	15.8	24.8	24.6	15.4

Source: Social Survey Report. Statistics Korea. 2013.

Currently Korean society is experiencing the third-age phenomenon, and incoming older cohort is more educated and willing to engage in empowering social and economic activities than preceding ones. In facing the aging of the population and the aging workforce over the past and coming decades, inevitable changes in various spheres are expected and lifelong learning is assuredly one of them. Working and learning are the centrality of human life, which means a human being enjoys the meaning of life with balance in work and learning. For the older adults, learning and working entails not only economic survival and achieving the meaning of life personally, but also lessening the social burden. At the same time the society benefits by increasing a more educated population, resulting in a positive economic impact.

International Visitor Arrivals (2009)

International arrivals
7,817,533 up 926,692 or 13.4% on the previous year

Key Markets	
Japan	3,053,111
China	1,342,317
U. S. A	611,327
Taiwan	380,628
Philippine	271,962

Annual Growth(%)	
Japan	28.4
China	14.9
U. S. A.	0.2
Taiwan	18.9
Philippine	-1.7

Purpose of Visit(%)	
Holiday	72.5
Business	3.9

Annual Growth(%)	
Holiday	22.5
Business	-19.3

Figure 9. Tourism in South Korea
source : KTO (2009)

The Tourism aspect of South Korea was increased in beginning of 21 centuries especialy from their neighbor (Japan and China) whose relatively have similar language (see figure 9). The leisure place in South Korea itself had universaly design for all, eventhough the signage problem also appeared (accessed at http://english.visitkorea.or.kr/) . The universal design application in leasure facilities are found basic problems on signage due to the Hangeul use without international

informations and transportation service officer who unable to speak in other languages. According to the situations, Korea government start to encourage people to study more other languages/cultures especially students and elderly.

Table 9 Character of tourist in South Korea
Source : Park, Sunga (2012)

Item	Variable	%
Gender	Woman	52.2
	Man	47.8
Age	60<	37.0
	50s	27.9
	40s	20.9
	30s	9.0
	20s	4.9
	10>	0.3

The bridge ramps installment for universal accessible and safe path shown that the leasure places were design for all and no barriers. Refer to the table 9, the majority of tourists are elderly aged above 60 and ladies shown that the places are low physical effort, accessible and tolerate the error.

CONCLUSSION

The Review revealed that South Korea has published research papers, regulations, guidelines and built a lot of public facilities based on universal design principles. South Korea has established universal design principles study as fundamental basis in designing and developing their public space, public facilities building and elderly residential houses. Application of universal design influenced the knowledge of diversity for people especialy in disability and elderly.

Universal design facilities in South Korea had proven able to encourage people with diversity in ability, ages, gender to live together without barrier to access and use every facilities in their regions. The various people participations without any barriers in sharing the public place showed that assistive physical environment, cognitive development and safety place are universal demands regardless their diversity.

The further development challenges of universal design principles in South Korea through previous studies are cognitives area and integrating the specialized user/exclusive design into universal design enrichments.

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